

air stream to the north and the northeastward-moving warm stream to the south of the center was an important factor. J. Bjerknes and H. Solberg¹³ have recently emphasized this point. On page 15 of the work cited they say:

At the limit between a polar current and a tropical current to the east of it the two currents are deflected from each other, so that an air deficit results above the region of their mutual limit. The low-pressure system, formed in that way, corresponds to a cyclone family.

And, again, on the following page:

As soon as an easterly polar current and a westerly tropical current become too strong a cyclone forms between them and makes the currents encroach upon each other, diminishing their differences of velocity.

CONCLUSION.

It seems reasonable to conclude, therefore, that maps representative of conditions at and above the average level of stations in the Plateau would be of assistance to the forecaster in distinguishing between those barometric gradients on the sea-level map which are real and those which are either erroneous or follow as a consequence of the hypsometric relation. Further, the change in the character of the weather after the storm passed from the Plateau to the Great Plains is plainly due to (1) the effect of stronger gradients near sea level becoming real through having an actual atmosphere in which to exist; (2) the sea-level gradients becoming stronger upon leaving the mountain district because of moderating effects in the reduction method; and (3) actual increase in intensity of the storm.

A CYCLONE WHICH CROSSED THE KOREAN PENINSULA

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With the twofold object of studying the phenomena induced by the passage of a cyclone directly across a mountain range, and of noting the behavior of the polar front in the Far East, the author makes a series of maps representing pressure distribution at sea level, at intervals of four hours between 10 a. m. March 24, and 2 a. m. March 26, 1918. Upon the assumption of a lapse rate of 6° C. per 1,000 meters for all stations, pressure maps at 3 kilometers above sea level are drawn to correspond to 6 of the sea-level maps.

At the time when the cyclone was 500 kilometers west of the Korean Peninsula, which "projects from the south-east coast of the Asiatic Continent in the direction of south-southeast, the width being from 200 to 300 kilometers, the length about 600 kilometers," and which contains a mountain range from 500 to 1,000 meters in height along its eastern coast, a secondary cyclone was induced on the eastern side of the peninsula, but it dis-

appeared within four hours. But by the time the cyclone had advanced 100 kilometers, a second secondary, with a well-developed polar front, had appeared. The formation of these secondaries, according to the author, is due to the strong wind of the primary storm being obstructed by the mountains.¹

The free-air maps show that these secondaries did not extend much above 3 kilometers and their axes are so inclined as to "wind themselves around the main cyclone."

A third secondary, associated with a sharp bend in the steering line, formed to the northeast of the main center. The free-air maps show the centers of the primary and the last two secondaries drawing gradually together, as if they were joined together at some higher level. The eastern secondary continually increased in intensity, while the primary diminished; the northern secondary finally joined with the eastern center, and finally the western center disappeared entirely. Thus, the cyclone crossed the peninsula.

Considering the cyclone from the Bjerknesian point of view, the behavior of the storm was quite normal, except as it was influenced by topography. Dr. S. Fujiwhara's new theory of the mechanism of extratropical cyclones (as yet unpublished) requires the presence of a horizontal vortex roll along the "cold front" having a counterclockwise sense of rotation facing the center, and of a similar vortex roll on the "warm front" of opposite sense of rotation, "and this vorticity makes the principal source of energy for the cyclone." The intersection of these warm and cold fronts with mountain ranges, induces secondaries, and produces anomalous wind directions. The phenomena shown in the Korean cyclone seem to confirm Doctor Fujiwhara's theory.

The following is the author's summary of the causes of secondaries:

(1) When a strong wind was obstructed by mountains, a secondary was induced kinematically in the shadow. (This kind of secondary vanishes soon if it does not connect with the polar front.) (2) When the steering line was cut by a mountain range, a secondary was induced on the eastern side of the range. (3) When the steering line curved sharply. (4) When the real polar air came after the cyclone had passed away, a secondary was produced in the cold sector, prolonging the steering line of the main cyclone to the west of its center. (5) Along the squall line when the fault of the isobars became very large.

The paper is concluded by miscellaneous remarks concerning the storm: the inclination of the axis of the cyclone is less over the sea than over the land. In the latter case, the lower part of the cyclone is nearer the sea than the upper portion.² This cyclone acts in accordance with Prof. T. Terada's conclusions from a statistical study of cyclones in the Far East, namely, that cyclones tend to pass over land in summer and tend to avoid land in winter.—C. L. M.

¹ Cf. Brooks, C. F.: On the origin of some secondary cyclones on the Middle Atlantic Coast. *MO. WEATHER REV.*, January, 1921, 49: 12-13.

² Preliminary studies of cyclones in the eastern United States show this same tendency, which is explained by strong contrasts of temperature between the southeast and northwest quadrants of the storm. In summer, the axis is more nearly vertical as was found to be the case over the sea, in Doctor Kobayasi's cyclone, probably due to the less-marked horizontal temperature contrast in the lowest 3 kilometers.—C. L. M.

¹³ Bjerknes, J., and Solberg, H.: Life cycle of cyclones and the polar front theory of atmospheric circulation. *Geofysiske Publikationer*, Vol. III, No. 1. Christiania, 1922.